The background of the slide is a grayscale underwater photograph. It shows a sandy seabed with various small rocks and shells. A large fish, possibly a cod or similar species, is visible in the upper right portion of the image, partially obscured by the text. The overall tone is muted and scientific.

How good do climate and ecosystem predictions need to be to be useful to the fisheries management process?

Application of Seasonal to Decadal Climate
Predictions for Marine Resource
Management Workshop

Princeton, New Jersey, 3-5 June 2015

Jon Hare
NOAA Fisheries

Anything is better than nothing?



NOAA Fisheries Mandates

Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) - Science-based conservation and management of fishery resources; prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery

Marine Mammal Protection Act (MMPA) – Protection of cetaceans and pinnipeds, regardless of their population status

Endangered Species Act (ESA) - Protection of those marine species listed as threatened or endangered, and for identifying candidate species for such listings

NOAA Fisheries Mandates

Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)

Marine Mammal Protection Act (MMPA)

Endangered Species Act (ESA)

Most Management, and Decisions Supporting these legislative mandates are based on Ecological Forecasts



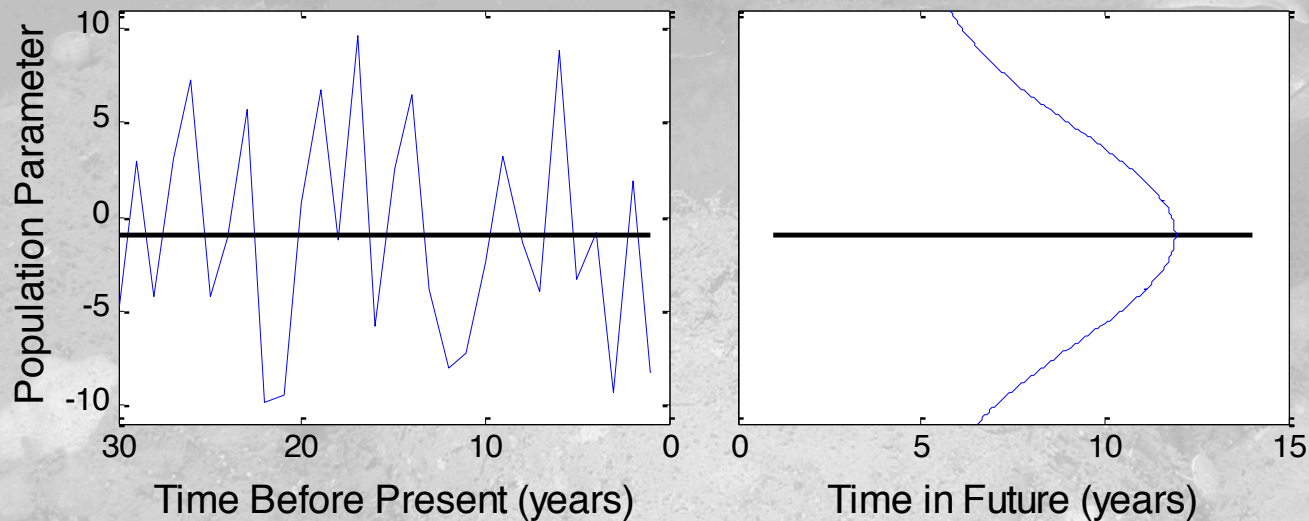
NOAA Fisheries Assessments (Forecasting)

Stock Assessment (somewhat different for MSFCMA, ESA, MMPA)

- Synthesis historical and current data (e.g., size, age, catch)
- Determine reference points for stock (e.g., optimum biomass; optimum fishing rate)
- Compare current status to reference points (e.g., overfished; overfishing)
- Project future status under fishing scenarios
- Estimate fishing rate to meet management objectives (e.g., optimum yield, rebuilding)
- Best available science provided to Fishery Management Councils to support management decisions

Assessments (Forecasting)

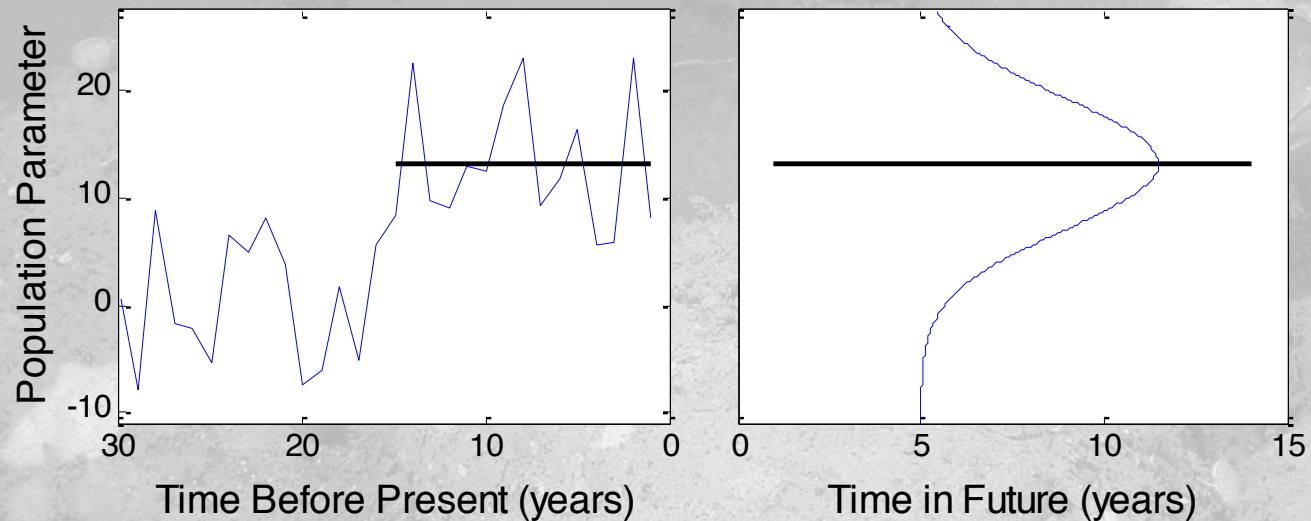
Population Model (Growth, Recruitment, Maturity, Mortality)



Modeled as stationary variables – constant mean with variability

Assessments (Forecasting)

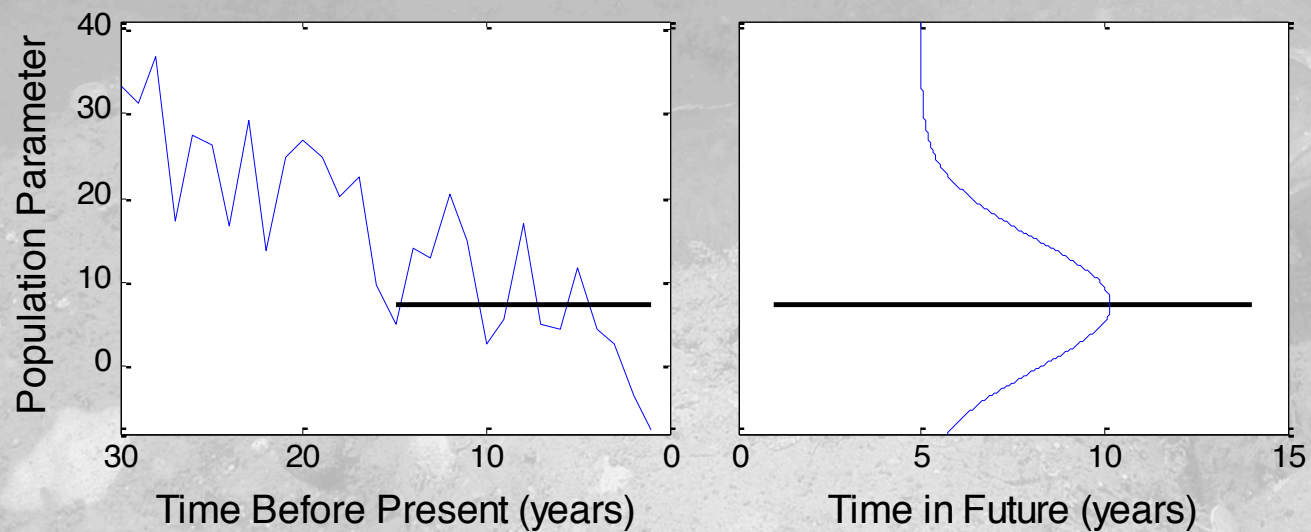
Population Model (Growth, Recruitment, Maturity, Mortality)



Choose different portions of historical data to “deal with” changes

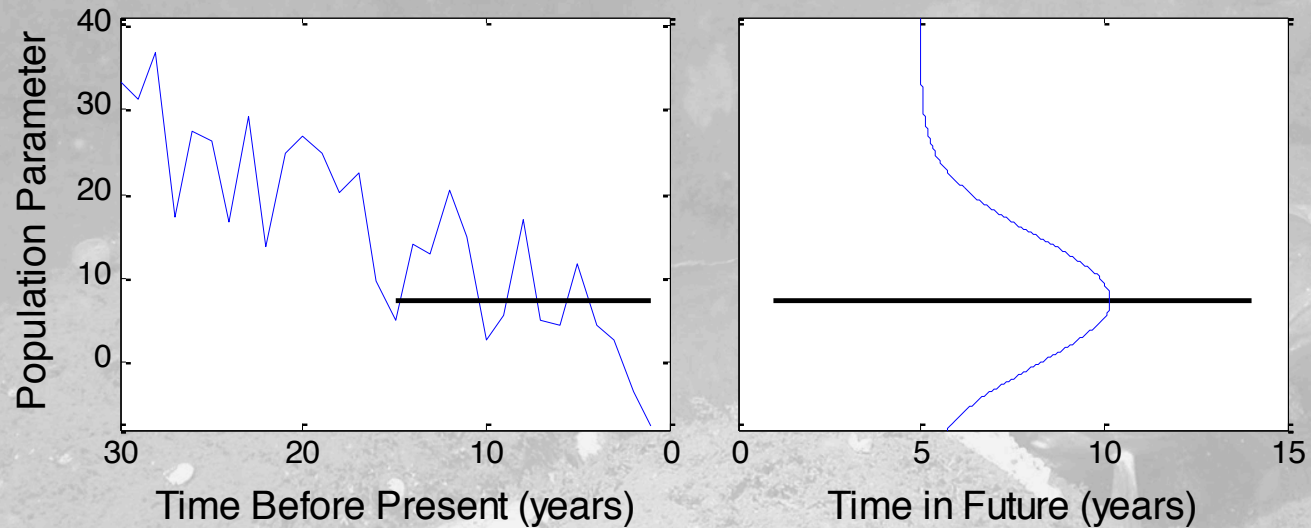
Assessments (Forecasting)

Population Model (Growth, Recruitment, Maturity, Mortality)



What if it is trend? Averaging the past, will be chasing the trend into the future

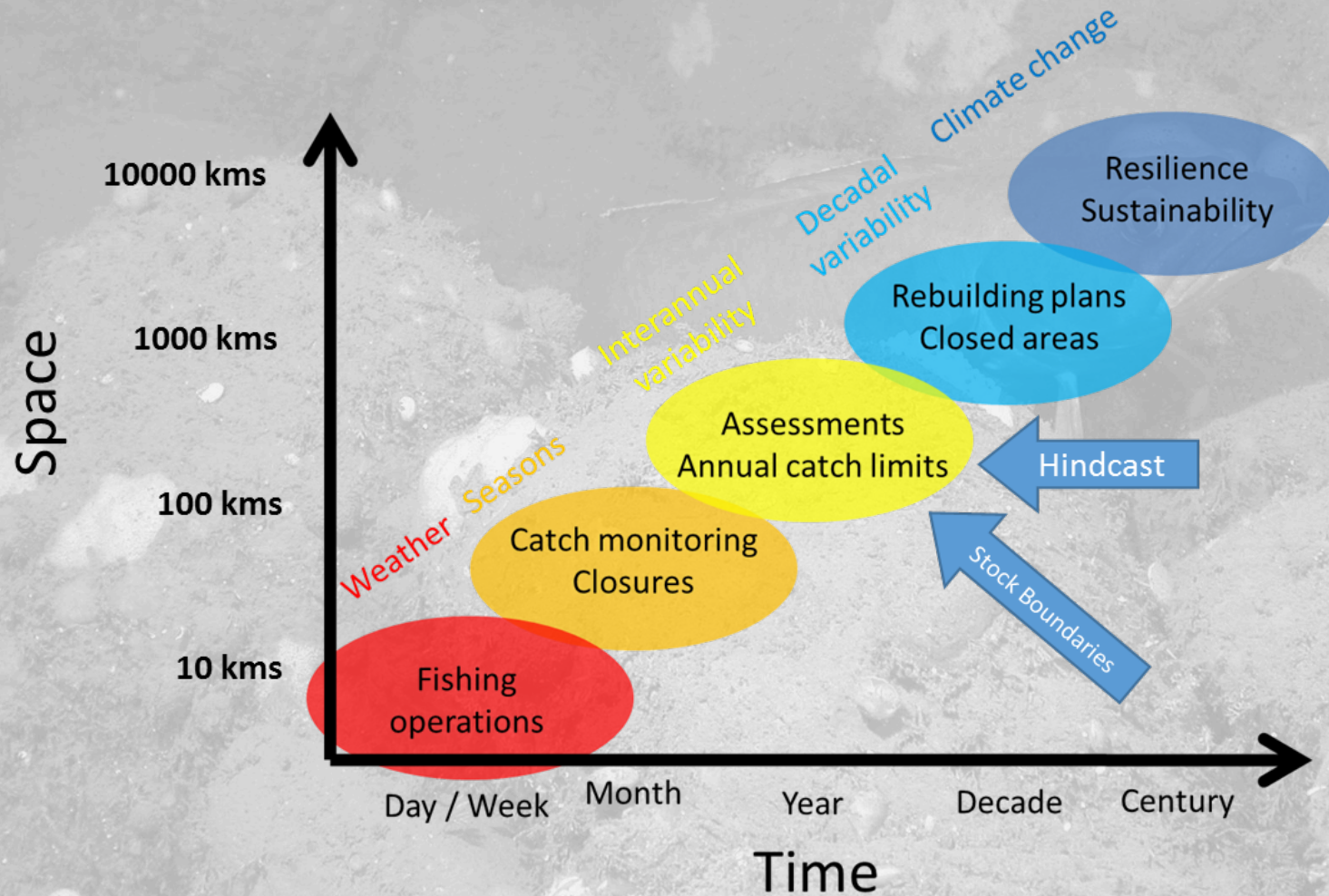
Assessments (Forecasting)



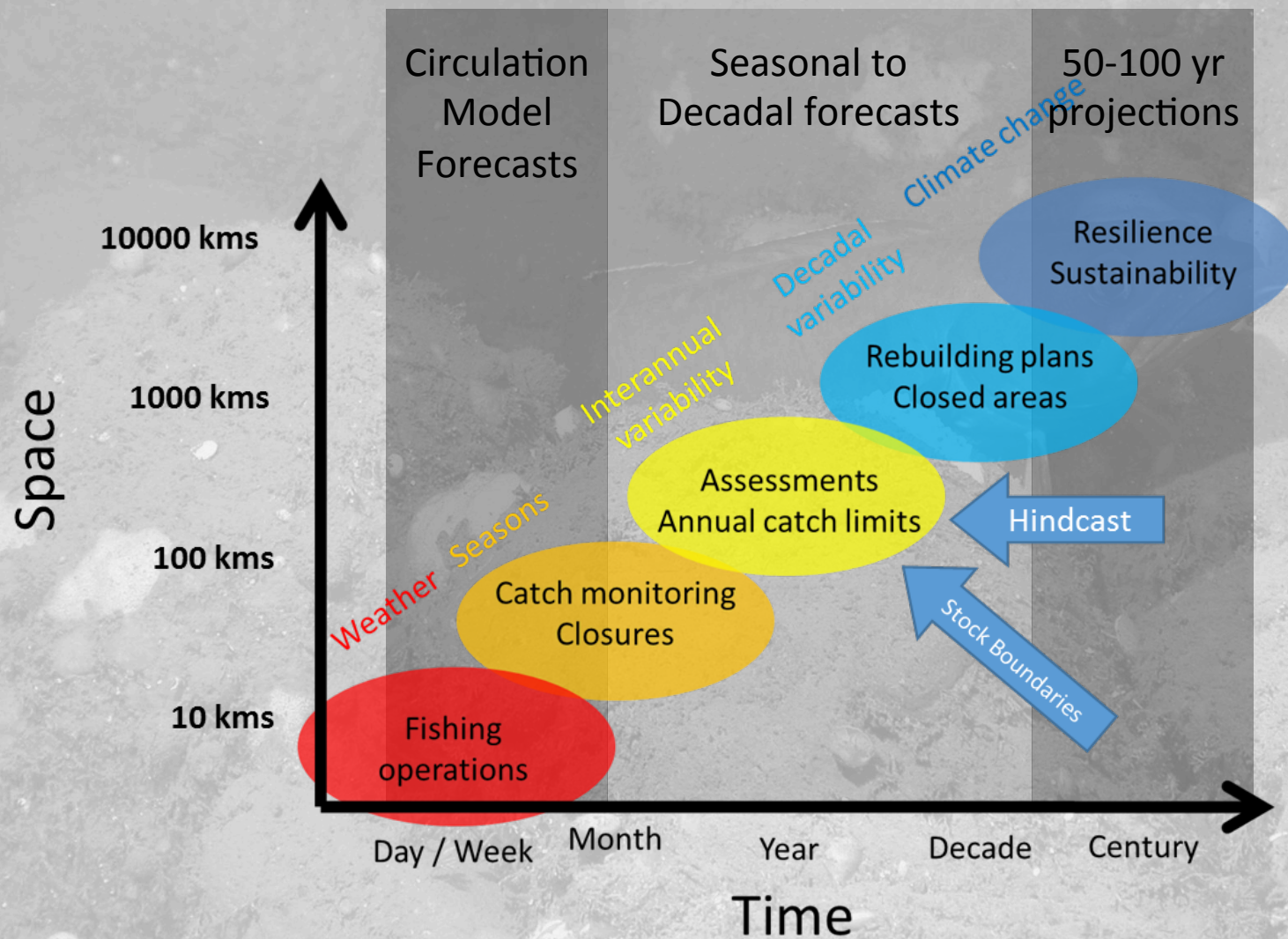
Developing and testing hypotheses for change

Incorporate hypothesis into assessment and forecasts

Scales of Fisheries Decisions



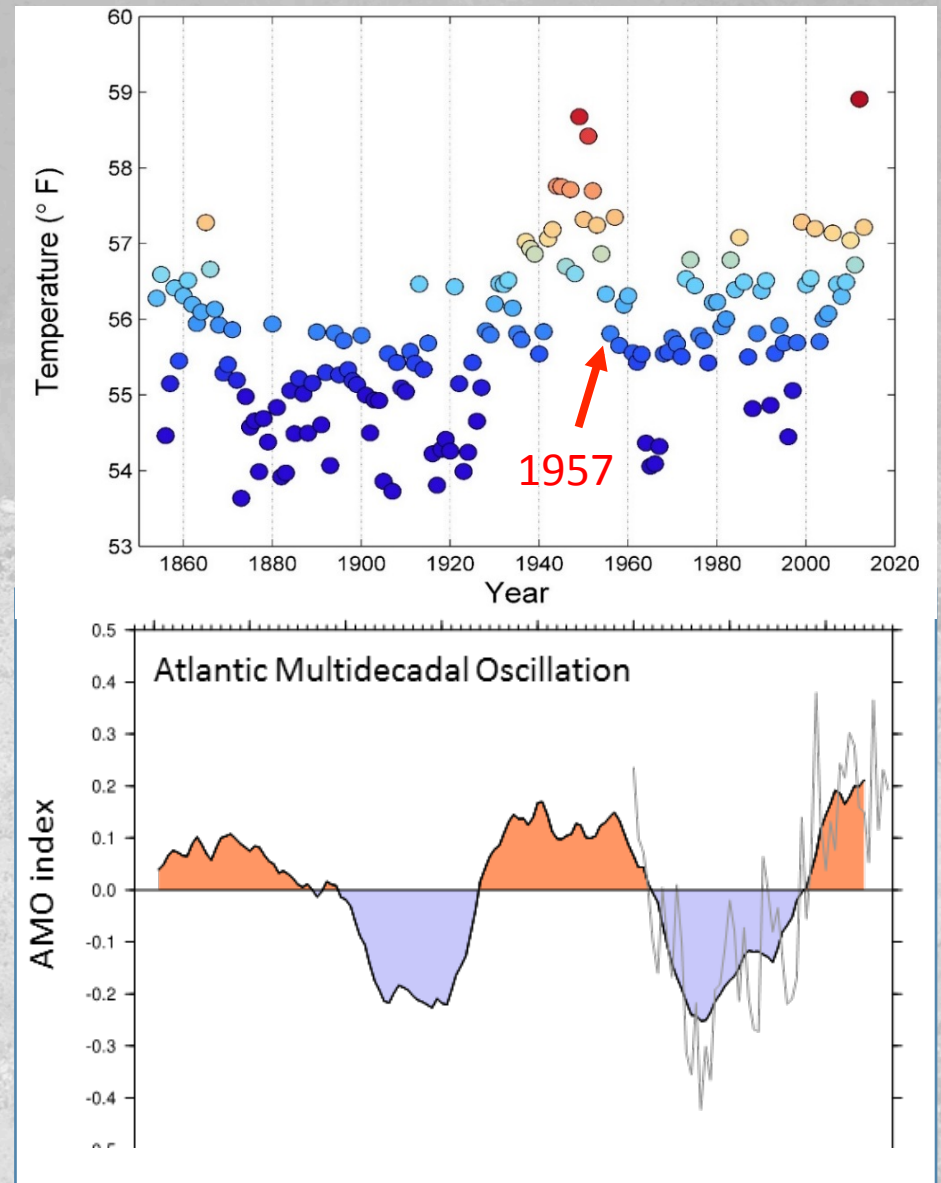
Scales of Fisheries Decisions



Scales of Fisheries Decisions

Northeast U.S. Shelf Ecosystem

- Seasonal Variability
- Interannual variability
- Multi-annual variability (e.g., NAO)
- Multi-decadal variability (e.g., AMO)
- Climate change



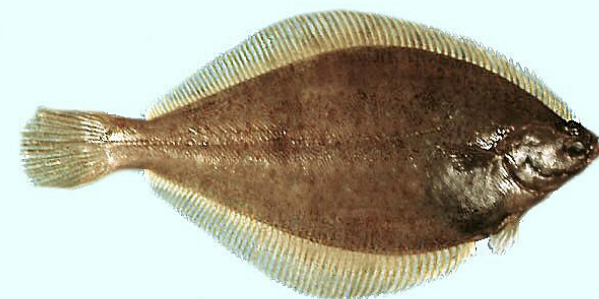
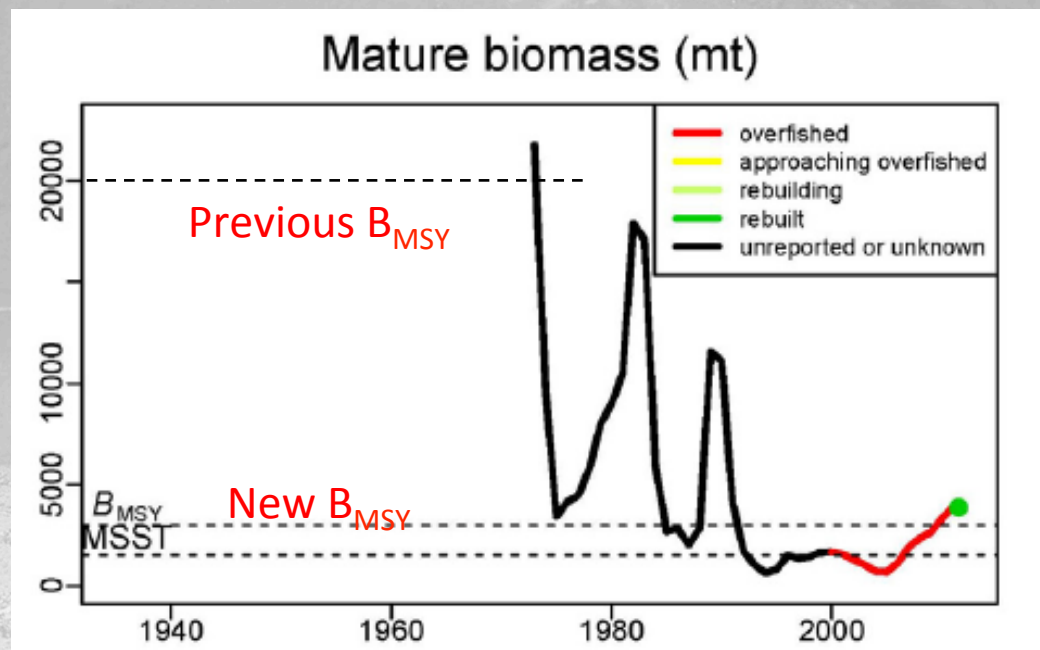
Annual Catch Limits

- Amount of fish that can be caught by fishermen over a period of one year.
- Often set for multi-year period
- Based on stock assessments and 3-5 year projections
- Seasonal to multi-year environmental forecasts are useful



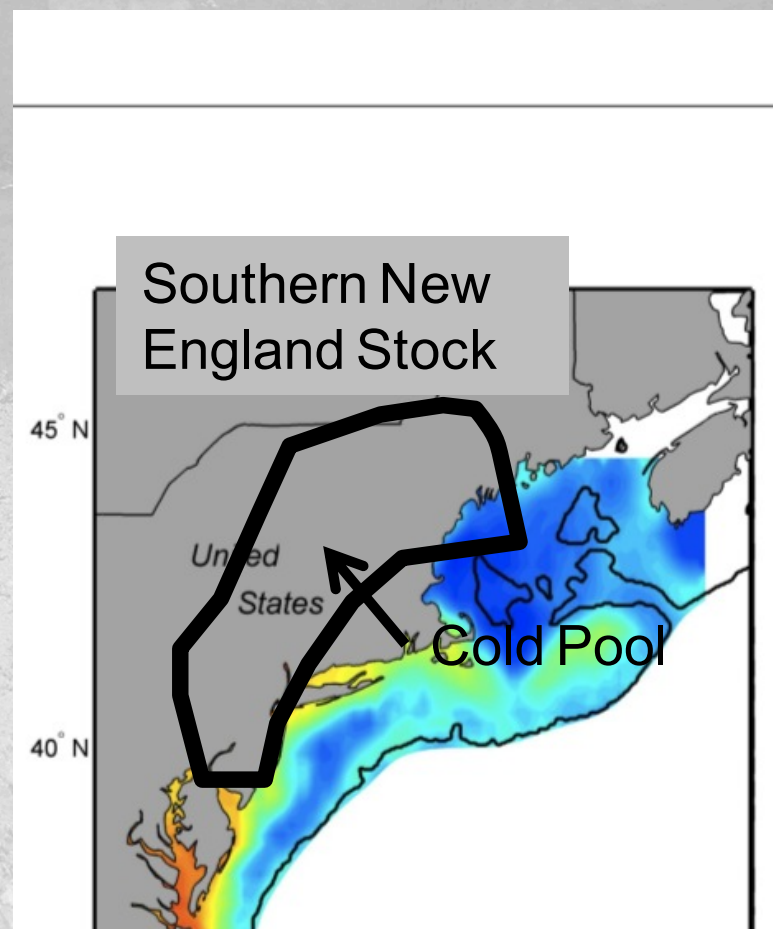
Annual Catch Limits

- Yellowtail Flounder status is dependent on length of time series used
- If stock entered new productivity regime in 1990 ...
- ... then stock is not overfished and is rebuilt



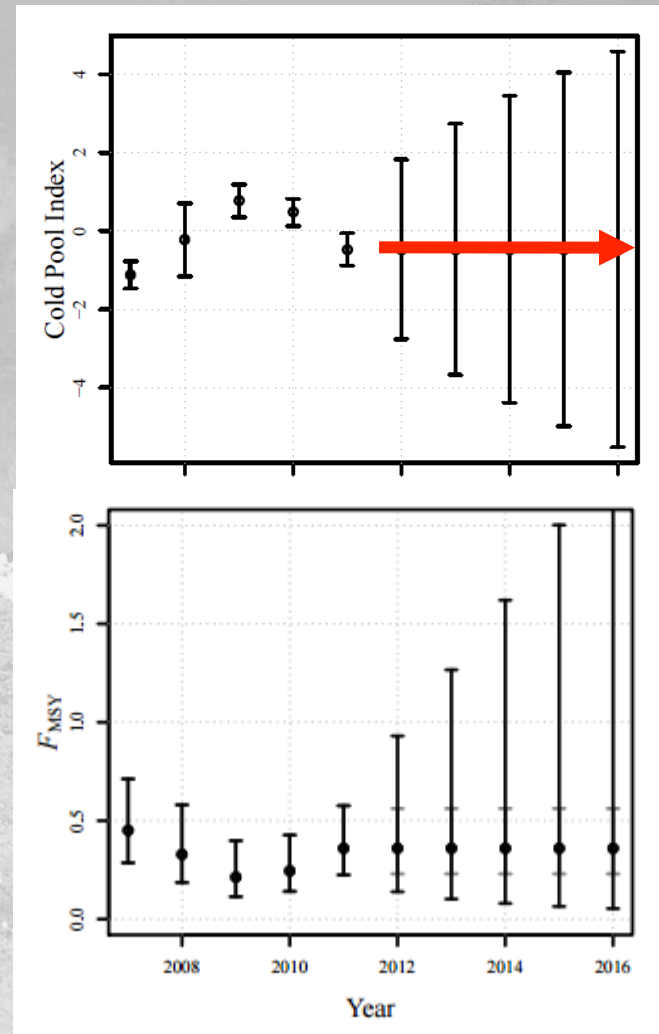
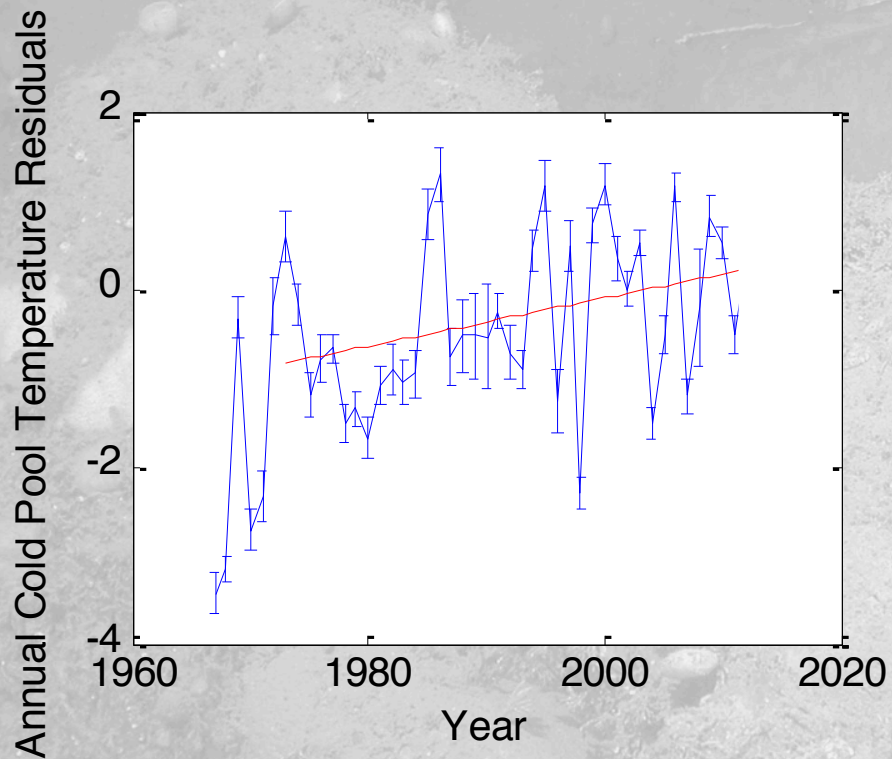
Annual Catch Limits

- Yellowtail Flounder recruitment linked to Cold Pool – area of remnant winter bottom water in MAB during summer (Sullivan et al. 2005 Fisheries Oceanography)
- FATE Supported Project –
Tim Miller NEFSC FATE FTE
Larry Alade NEFSC
Assessment Lead



Annual Catch Limits

- Project population in future
- Stationary environmental index



Miller et al. in prep

Rebuilding Plans

- A stock (population) is overfished (below an abundance reference point)
- Legal mandate to develop rebuilding plan to reduce fishing to allow stock to recover to reference abundance w/i 10 years (there are caveats)
- Develop population model, forecast population in future and use different fishing scenarios
- Set fishing based on scenario that has stock “rebuilt” in 10 years

Rebuilding Plans

In New England – 16 of 38 stocks are under rebuilding plans

In Mid-Atlantic – 0 of 11 stocks are under rebuilding plans

10+ year climate projections are needed / useful



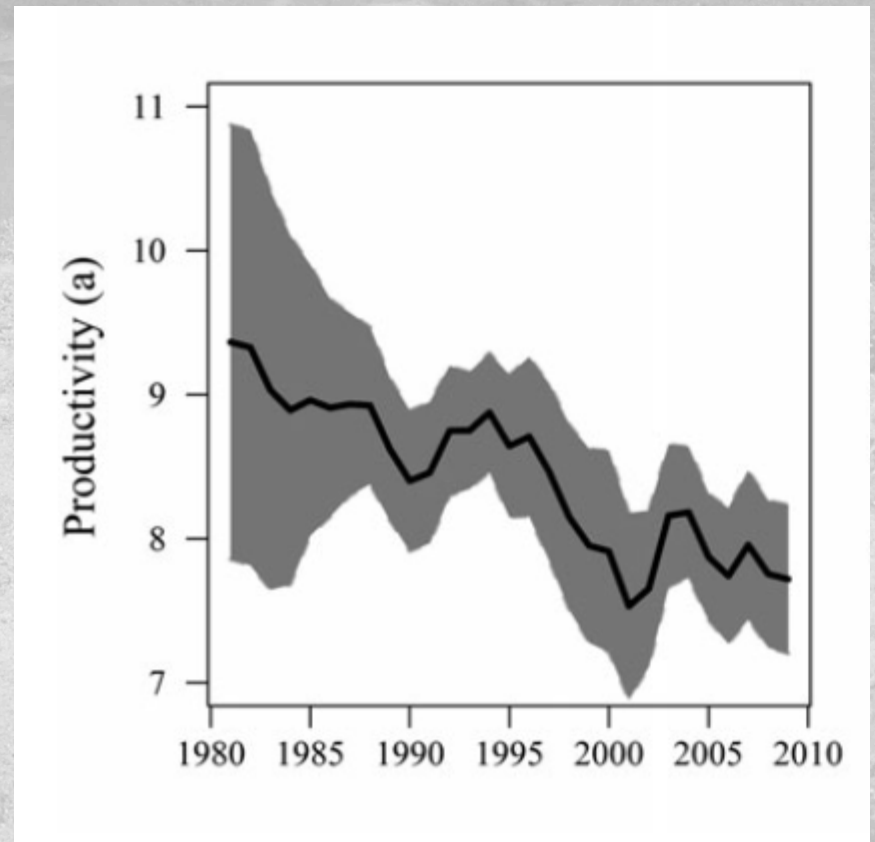
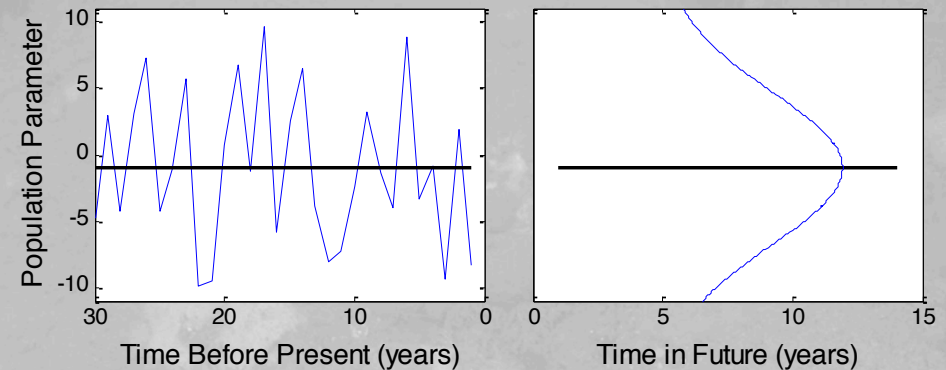
Example: Southern New
England Winter Flounder

NMFS Habitat Program

Rich Bell – NRC Post-Doc,
NEFSC

Rebuilding Plans

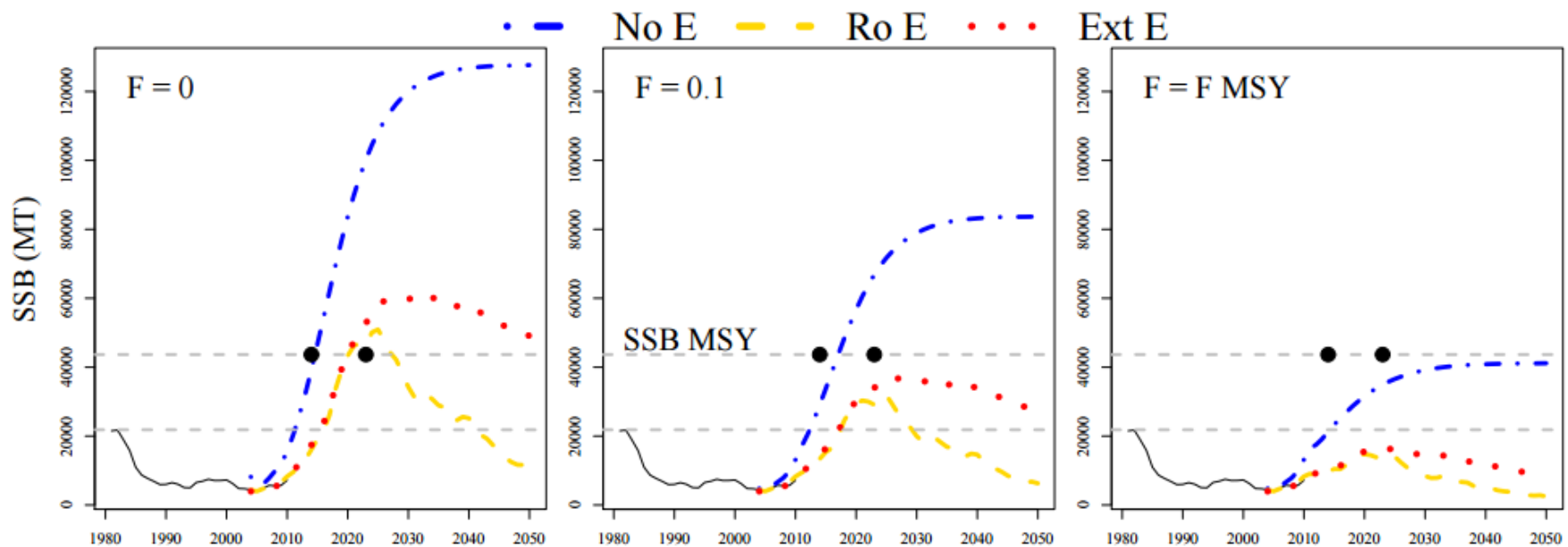
- Assessment and rebuilding plan assumes population productivity is stationary
- Research suggestion productivity is declining
- Related to estuarine temperatures (which are increasing)



Bell et al. (2014) ICES Journal of Marine Science

Rebuilding Plans

- Using AR4 climate models and ASAP assessment model, rebuilding projections affected by climate
- Currently updating with AR5 models



Bell, Wood, et al. (in prep)

Scales of Fisheries Decisions

Time scale of forecast - projection

By-catch forecasts (days) – River Herring Turner et al. (submitted)

Survey availability forecasts (days to weeks) – Butterfish Manderson et al. (in prep)

Seasonal catch advice (weeks to months) – No specific examples, but possible

Annual catch limits (years) – Yellowtail Flounder Miller et al (in prep)

Rebuilding (years to decades) – Winter Flounder Bell et al. (in prep)

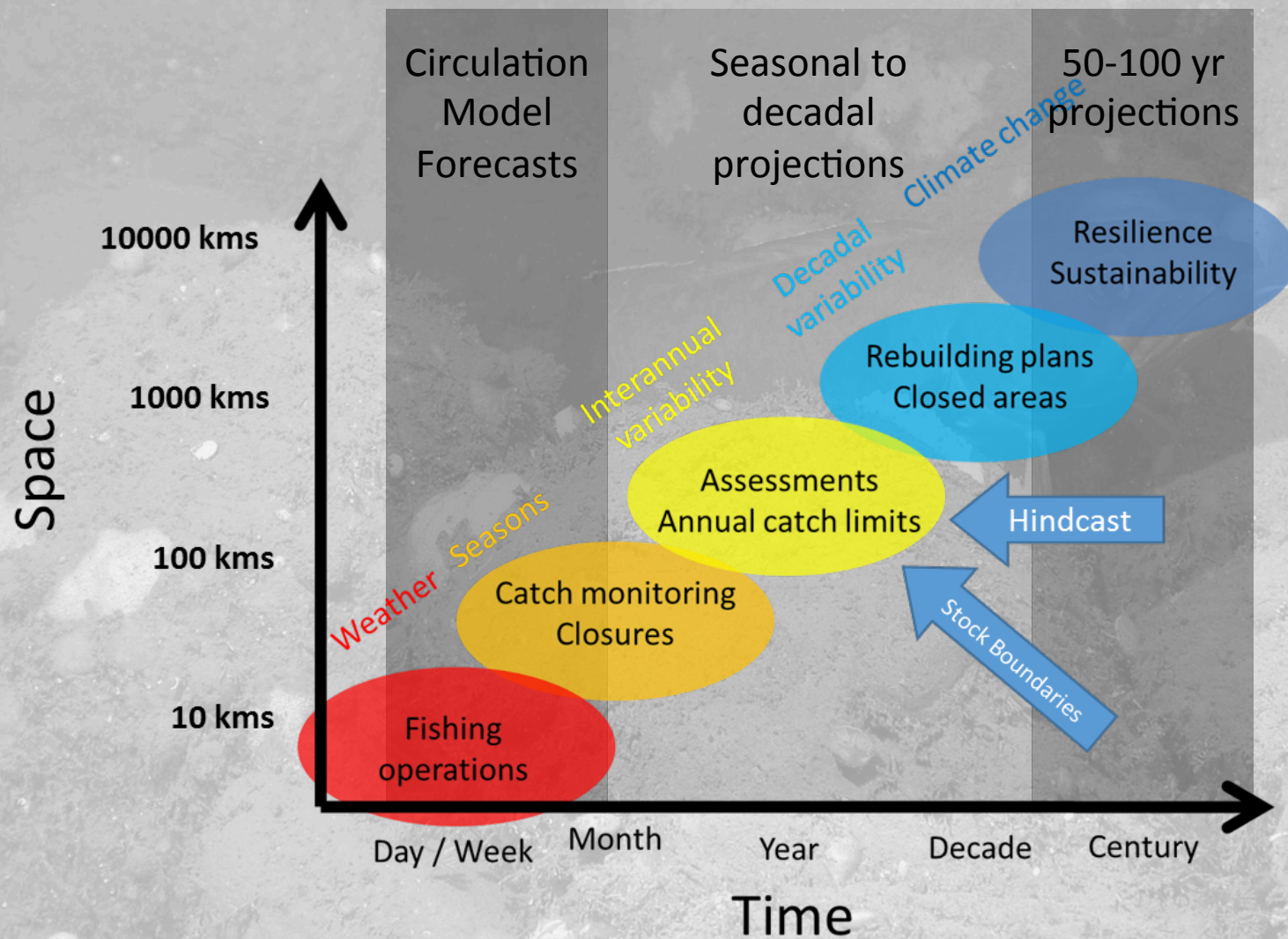
Sustainability and Warming Projections (decades) – a number of examples

Sustainability and OA Projections (decades) – Sea Scallop Cooley et al (2015)
includes bio-economic model

Atlantis and OA Projections (decades) – Fay et al. (in prep)

Atlantis and Warming (decades) – Nye et al. (2013)

Scales of Fisheries Decisions



How good do climate and ecosystem predictions need to be for fisheries management process?

- Ability to couple with population or ecosystem model (mechanics and hypothesis/mechanism)
- Ability to include fishing (the dominant driver)
- Skill in forecasting mechanism at necessary time scale (e.g., coastal temperature, cold pool)
- Ability to quantify uncertainty in forecast (e.g., within or between model ensembles, propagate errors)
- Spatial resolution to capture mechanism (e.g., likely higher AR5)
 - i) dynamical downscaling
 - ii) high-res climate model

Questions?



Photo by: Chris Melrose